Preface

This book is an overview of many different but interrelated and ongoing studies of cognitive neuroscience for healthcare. Cognitive neuroscience is an interdisciplinary field of both psychology and neuroscience, which is focused on neural mechanisms of mental processes. Due to its multidisciplinary characteristics, cognitive neuroscientists often have backgrounds in a variety of fields such as psychology, computer science, bioengineering, philosophy, mathematics, and medical science. Healthcare is the diagnosis, treatment, and prevention of disease, illness, injury, and other physical and mental impairments in humans. In combining cognitive neuroscience with healthcare, we can provide objective criteria for the diagnosis and prevention of diseases or mental impairments in humans.

The application of neuroimaging technology to the study of cognitive neuroscience and healthcare has been steadily increasing. Using non-invasive MRI (magnetic resonance imaging), fMRI (functional magnetic resonance imaging), EMG (electromyogram), CT (computed tomography), MEG (magnetoencephalography), and ERPs (event-related potentials), changes in the DMN (default mode network) state have been found and linked to the diagnosis of dementia. The majority of neuroimaging studies that have contributed to the understanding of the pathophysiology and clinical course of dementia have utilized structural magnetic resonance imaging (MRI) and positron emission tomography (PET). In addition, by observing the behavioral cognition, abnormal results could highlight related mental illnesses. Thus, the early diagnosis of mental illnesses could be achieved by using several cognitive neuroscience methods, such as those mentioned above, and this is of importance since the data could provide useful advice for healthcare before the onset or during the early stages of the illness.

The purpose of this book is to bring together researchers and practitioners, including engineers, medical doctors, health professionals, and neuroscience/informatics/computer scientists, who are interested in both theoretical advances and applications of information systems, artificial intelligence, signal processing, electronics, and other engineering tools in biomedical areas related to cognitive neuroscience and medicine. We consider the following activities of cognitive neuroscience and healthcare:

Section 1: Cognitive neuroscience and healthcare (Chapters 1-12)
Section 2: Imaging cognitive neuroscience and healthcare (Chapters 13-21)
Section 3: EEG/ERP cognitive neuroscience and healthcare (Chapters 22-35)
Section 4: Cognitive science and healthcare (Chapters 36-37)
Section 5: Mental health (Chapter 38)

Section 1 of this book is concerned with cognitive neuroscience and healthcare. This part includes 12 chapters, which are focused on many research fields in cognitive neuroscience and healthcare. For example, we will see that visual perception might be built upon several levels of crossmodal synchro-
nization from nonvisual modulations of visual competition (Kohske Takahashi and Katsumi Watanabe, Chapter 7). In addition, for helping people who cannot walk, researchers not only performed a large number of studies on walking support or walking rehabilitation machines, but also investigated the motor brain function (Renpeng Tan, Shuoyu Wang, and Yinlai Jiang, Chapter 3; Yinlai Jiang, Shuoyu Wang, Renpeng Tan, Kenji Ishida, Takeshi Ando and Masakatsu G. Fujie, Chapter 4). For the treatment of CRPS (complex regional pain syndrome), virtual reality technology has been applied (Akio Gofuku, Satoshi Fukumori, and Kenji Sato, Chapter 8). Using the Behavioral Assessment of the Dysexecutive Syndrome (BADS), researchers have found that the ExD (Executive dysfunction) in PD (Parkinson’s disease) could be caused by frontal dysfunction (Satoshi Kamei, Chapter 2). We will also see that, for mental health, the brain regions that accommodate the schema proposed herein are assumed to respond during the detection of errors relative to a prediction; consequently, this neural response may be used for diagnosis and evaluation of mental disorders and health (Motoaki Sugiura, Chapter 1).

Section 2 of this book is concerned with imaging cognitive neuroscience and healthcare. This part includes 9 chapters, which are focused on many research fields in the application of imaging technology in cognitive neuroscience and healthcare. Researches on the effects of acupuncture (an ancient Chinese healing methodology) on brain activity and connectivity have been investigated and concluded (Bin Yan, Yu Lei, Li Tong, and KeWei Chen, Chapter 15). Munetaka Haida (Chapter 13) has suggested a simple model to interpret the NIRS (near infrared spectroscopy) signal using the electromagnetic waves (EMWs). Researchers have also provided a method for estimating the topographical distribution of Visual Evoked Potentials (VEPs), which is combined with the mathematical models and EMG (Takenao Sugi, Kazuhiko Goto, Satoru Goto, Yoshinobu Goto, Takao Yamasaki and Shozo Tobimatsu, Chapter 14).

Section 3 of this book is concerned with EEG/ERP cognitive neuroscience and healthcare. This section includes 14 chapters, which are focused on the application of EEG and ERP techniques in cognitive neuroscience and healthcare. Using the high time resolution characteristics of EEG or ERPs, we could instantly assess brain activity. For example, Chapter 28 (Sunao Iwaki) describes a technique to combine data from MEG, MRI and fMRI to visualize human visual processing while perceiving a three-dimensional (3-D) shape. Others have found that the visual perception of concrete Chinese characters was different from the visual perception of absolute characters with evoked potentials (Ichiro Shimoyama, Hitoshi Shimada, and Toshiaki Ninchoji, Chapter 27). Researchers have also proposed that sleep management promotes a healthy lifestyle, a better mental health quality of life (QOL), and a healthy brain, and suggested that cognitive-behavioral interventions to improve sleep practices are effective for mental health, activity of daily living (ADL), and quality of life (Hideki Tanaka, and Maki Furutani, Chapter 22). Moreover, the major rehabilitation approaches that have been attempted to improve the cognitive functions and QOL of elderly people with dementia have been summarized, and a new approach for improving the cognitive functions of elderly people with dementia has been introduced (Hitoshi Okamura, Chapter 24).

Section 4 of this book is concerned with cognitive science and healthcare. This section includes 2 chapters, which are focused on what cognition is, what it does, and how it works. Although the application of neuroscience technology, such as EEG and fMRI, was very popular, the experimental designs of cognitive neuroscience were mostly based on cognitive science. As you would expect, the combination of cognitive science and healthcare is helpful for patients. For example, Satoru Okamoto, Tetsuya Hirotomii, Keigo Aoki, and Yasutomo Hosomi (Chapter 36) have inferred that methods using acceleration sensors are suitable for the discovery of the average gait motions of elderly patients living in nursing homes and can be used to evaluate walking motion before and after rehabilitation. In addition, the trade-off between
speed and accuracy is an important factor that should be controlled during experiments. In Chapter 37, the speed-accuracy trade-off models of target-based and trajectory-based movements have been discussed.

Section 5 (Chapter 38) of this book is concerned with mental health. Some data suggest that almost 60% of the workers in Japan are affected by psychological stress in their daily work, particularly in human relations. Hideo Tamba has summarized workers’ mental health problems and future perspectives. He has concluded that it is crucial to understand the situation of actual workers. When both the negative and positive aspects of mental health are understood together, interventions will be more effective.

In summary, from the basic visual to the healthcare of dementia, we have comprehensively brought together the latest cognitive neuroscience and healthcare researches. As you will see, the five parts are not independent. Instead, they take different perspectives to provide an overview of cognitive neuroscience and healthcare and the topics covered are often related. Readers should choose any of the research fields according to their interests. We hope this book will help you to learn more about cognitive neuroscience and healthcare, and bring benefits to your own research.

Jinglong Wu
Okayama University, Japan